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TWO NEW SPECIES OF THE GENUS SILICULA (BIVALVIA: SILICULIDAE) FROM THE NORTHWESTERN PACIFIC, WITH NOTES ON SILICULA SANDERSI (BERNARD, 1989) AND PROPELEDA SOYOMARUAE (OKUTANI, 1962)

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ABSTRACT

Two new species, Silicula beringiana and S. okutanii, are described from the northwestern Pacific. These species have an elongate shell with extended and tapered posterior end, dif-fering from each other in form and proportions. Silicula beringiana was found in the Bering Sea, Kamtchatky Strait, and near the southeastern coast of Kamchatka (Pacific Ocean) at 489-4,984 m depth. Silicula okutanii was found in the Pacific Ocean at a latitude of the north-ern part of Japan at 5,219-5,352 m depth. Silicula sandersi (Bernard, 1989) and Propeleda soyomaruae (Okutani, 1962) were re-examined. Based on comparison with the description, pictures and photos of the type species of Silicula Jeffreys, 1879, Lamellileda Cotton, 1930, Poroleda Hutton, 1893, and Propeleda lredale, 1924, the following combinations are suggested: Lamellileda sandersi Bernard, 1989, and L. soyomaruae (Okutani, 1962).
Key words: Silicula, bivalve mollusks, systematics, morphology, distribution, Pacific Ocean.

INTRODUCTION

Allen & Sanders (1973) placed the genus
Silicula Jeffreys, 1879, in the family Siliculidae,
which they erected following the investigation
of deep-water Protobranchia of the Atlantic
Ocean. Earlier, the genus Silicula comprised three species: Silicula fragilis Jeffreys, 1879, Silicula patagonica (Dall, 1908), and Silicula rouchi Lamy, 1910. Allen & Sanders (1973) described two new species - Silicula filatovae Allen & Sanders, 1973, and Silicula mcalesteri Allen & Sanders, 1973 — and examined, in great detail, the shell morphology and anatomy of all species of the genus Silicula, except S. patagonica, which was described from a single valve with a destroyed beak (Dall, 1908). Later, Bernard (1989) described one more species Silicula alleni Bernard, 1989. In the same work, he described the species Lamellileda sandersi Bernard, 1989, which Coan et al. (2000) re-ferred to the genus Silicula. Thus, the genus Silicula currently contains seven species that were recorded in the bathyal and abyssal zones
of different regions of the Atlantic and Pacific oceans. However, despite the wide distribu-tion of Siliculidae representatives in the World Ocean, collections of Silicula species in most cases consist of a small number of specimens.

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In the Pacific Ocean, the siliculids $. patago-nica, S. alleni, and $. sandersi were found only at the coast of America, and all Pacific species were described from a minimal amount material
— S. patagonica from one valve, S. alleni and
S. sandersi from one specimen each. Following the examination of extensive original material of bivalves collected during the period from 1950 to 2012 in the bathyal and abyssal zones of different regions of the northwestern Pacific, two new species of Si-licula were discovered. One was recorded in the bathyal and abyssal of the deep-sea basin of the Bering Sea and the other in an abyssal plain of the northwestern Pacific. Thus, the new representatives of the genus Silicula were first recorded in the western Pacific Ocean. The present paper mainly focuses on the descrip-tion of these new species.

MATERIALS AND METHODS

Material Studied

In this study, | used the material collected by expeditions of IO RAS in the bathyal and abys-sal zones of the Bering Sea (R/V “Vityaz”, cruise 5, August 5-October 5, 1950; R/V “Vityaz”,

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cruise 8, September 14-October 28, 1951; R/V “Akademik Mstislav Keldysh”, cruise 22, July 25—October 27, 1990) and in the abyssal zone
of the northern Pacific (R/V “Vityaz”, cruise 45,
April 23—July 10, 1969; R/V “Akademik Mstislav Keldysh’, cruise 22, July 25—October 27, 1990), as well as by the German-Russian deep-sea expedition KuramBio (Kurile Kamchatka Bio-diversity Study) in the abyssal zone of the northwestern Pacific (R/V “Sonne”, cruise 223, July 21-September 7, 2012). The material of Silicula species collected by the IO RAS was fixed and stored in 70% ethanol in the lO RAS. The material collected by the KuramBio expedi-tion was fixed in pre-cooled 96% ethanol and stored in the IMB.
The following were used for the comparison purposes: the type material of P soyomaruae (holotype NSMT Mo 62762, paratype NSMT 49827), photos of type and other materials of S. mcalesteri (holotype MCZ 271974, paratype MCZ 361654, photos by A. J. Baldinger from MCZ website), S. filatovae (holotype MCZ 271977, paratype MCZ 361653, photos by A. J. Baldinger from MCZ website, “President and Fellows of Harvard College”), S. alleni (holotype LACM 2344, photos by L. T. Groves and P. Valentich-Scott), S. sandersi (holotype LACM 2348, photos by L. T. Groves and P. Valentich-Scott), S. patagonica (holotype USNM 96914, photos from USNM website (“Information provided with the permission of the National Museum of Natural History, Smith-sonian Institution, 10th and Constitution Ave. N.W., Washington, D.C. 20560-0193 (http:// www.nmnh.si.edu/)”), $. fragilis (МММ, im-age numbers: M011725, M011726, MO11727, from Marine Bivalve Shells of the British Isles website (Oliver et al., 2010)), and S. rouchi (USNM 870326, photos from USNM website (‘Information provided with the permission of the National Museum of Natural History, Smith-sonian Institution, 10th and Constitution Ave., N.W., Washington, D.C. 20560-0193 (http:// www.nmnh.si.edu/)”); photos of 2 specimens by D. G. Zelaya).

Shell Measurements

Figure 1 shows the shell morphology mea-surements. Shell length (L), anterior end length (A), height (H) and width (W) were measured for shells. The ratios of these parameters to Shell length (A/L, H/L, W/L, respectively) were determined. Shell measurements were made using a Caliper and an ocular micrometer with an accuracy of 0.1 mm.

Methods

The statistical analysis was performed based on the calculated indices (A/L, H/L, W/L) which are less susceptible to change compared with other measured parameters using Data Analy-sis Module of MS Excel 97-2003. All indices for pairs of shells of Silicula species were compared using the Student (T) parametric test and one-way analysis of variance (ANOVA). Throughout this study, statistical significance was defined as P < 0.05.
For scanning electron microscopy, shells were cleaned of traces of soft tissues and periostracum in diluted commercial bleach, washed in distilled water, and dried. They were then mounted to aluminium stubs using an adhesive tape and coated with gold for examination with an EVO 40XVP.
Gross anatomy was observed on preserved live-taken specimens. For anatomical studies, several specimens of species from the Bering Sea and two specimens with broken shell of species from the Pacific Ocean were dissected in 70% ethanol and drawn schematically.

Abbreviations

The following institutional abbreviations are used in the paper:
IMB — A.V. Zhirmunsky Institute of Marine Biology, Far Eastern Branch of the Russian Academy of Sciences, Vladivostok
lO RAS —P. P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Moscow

FIG. 1. Placement of shell measurements: L — shell length; Н — height; A — anterior end length; W — width.

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TABLE 1. Main differentiating characters of genera Silicula, Poroleda, Propeleda and Lamellileda.

Silicula Jeffreys,
Characters 1879

Shell
longer posteriorly,
sometimes rostrate

Posterodorsal Straight, sometimes
Shell Margin slightly convex or
concave

Anterior Teeth Long, lamellate, almost V-shaped parallel to anterodor-
sal shell margin

Posterior Teeth Very long, lamellate,
almost parallel to
posterodorsal shell
margin margin

References
Heinberg, 1989;
Coan et al., 2000 1989

Poroleda Hutton,
1893

Slightly concave

Short, lamellate,
oblique to pos-
terodorsal shell

Allen & Sanders, 1973; Hedley, 1905,
1915; Heinberg,

Propeleda lredale, Lamellileda Cotton,
1924 1930

Elongate, inequilateraVle,r y elongate, low, Elongate, inequilater- Very elongate, low, very inequilateral, al, longer posteri-extended posteri-
orly, rostrate

very inequilateral,
extended posteri-
orly, rostrate

orly, rostrate

Strongly concave,
sometimes straight

Slightly concave

Numerous, V-shaped, Short, subequal, sometimes a few lamellate, hori-lamellate near beak тома

Numerous, V-shaped Long, lamellate, and a few lamellate oblique to pos-near beak terodorsal shell margin

Cotton, 1930;
Ludbrook, 1961;
Heinberg, 1989

Hedley, 1915; Nijs-
sen-Meyer, 1972;
Heinberg, 1989

LACM - Natural History Museum of Los Ange-les County, Los Angeles
MCZ - Museum of Comparative Zoology, Har-vard University, Cambridge
ММВ — Museum of the Institute of Marine Biol-ogy, Vladivostok
NMW - National Museums & Galleries of Wales, Cardiff
NSMT - National Museum of Nature and Sci-ence, Tsukuba
USNM — United States National Museum of Natural History, Smithsonian Institute, Wash-ington, D.C.
ZMMU - Zoological Museum of Moscow Uni-versity, Moscow

SYSTEMATICS
Family Siliculidae Allen & Sanders, 1973 Genus Silicula Jeffreys, 1879

Type Species - Silicula fragilis Jeffreys, 1879

Diagnosis

Shell small (< 20 mm), very thin, fragile, often translucent, very compressed, elongate, inequi-lateral, longer posteriorly, sometimes abruptly and somewhat squarely truncated, with anterior

and posterior ends gaping. Surface with very weak, dense, shiny, commarginal ribs, often with widely spaced and weak, radial rays of short and very dense riblets. Beaks very small, not prominent, prosogyrate. Lunule and escutcheon absent. Periostracum thin, adherent. Hinge plate very narrow, weak. Teeth long, lamellate, almost parallel to posterior shell margin, partially over-lapping each other, anteriorly and posteriorly increasing in length, divided into anterior (up to 6 teeth) and posterior (up to 8 teeth) sets. Anterior teeth shorter than posterior. Ligament internal, elongate, opisthodetic, posteroventrally directed. Resilifer deep, elongate, oblique, pos-terior to beaks. Pallial line with shallow pallial sinus of same shape and size in both valves. Pallial sinus not confluent with pallial line.

Remarks

The genus Silicula is most close in terms of the hinge structure to the genera Lamellileda Cotton, 1930, and Poroleda Hutton, 1893 (Figs. 2-12). Like Silicula, species of Lamellileda and Poroleda have long and lamellate teeth (Hedley, 1905; Cotton, 1930, Ludbrook, 1961) (Table 1). This has hampered the identifica-tion of generic status of species that occur in different regions of the World Ocean and have

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lamellate teeth in the hinge (Heinberg, 1989). In
the northern Pacific, such species are Silicula sandersi (Bernard, 1989) and Propeleda soyo-maruae (Okutani, 1962) (Figs. 13-24).
Huber (2010) suggested that Bernard (1939) originally correctly placed $. sandersi in Lamel-lileda. Silicula sandersi was described from one specimen from the abyssal plain (5,180 m

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depth) of the northeastern Pacific. In contrast to other species of the genus Silicula, this species has a much more extended poste-
riorly and more rostrate shell; more than 10
relatively short posterior hinge teeth, becoming
posteriorly shorter and oblique relative to the
posterodorsal shell margin; more than 5 short
subequal anterior teeth located horizontally and

FIGS. 2-12. Species of genera Lamellileda, Poroleda, Propeleda, and Silicula. FIGS. 2, 3: Lamellileda typica Cotton, 1930 (type species of Lamellileda), holotype, shell length 11.2 mm (from Cotton, 1930); FIGS. 4, 5: Lamellileda tatei (Hedley, 1904), holotype, shell length 11.7 mm (from Ludbrook, 1961); FIGS. 6, 7: Poroleda lanceolata (Hutton, 1885) (type species of Poroleda), shell length 13.8 mm (from Hedley, 1905); FIGS. 8, 9: Poroleda spathula Hedley, 1915, holotype, shell length 14.0 mm (from Hedley, 1915); FIGS. 10, 11: Propeleda ensicula (Angas, 1877) (type species of Propeleda), shell length 11.0 mm (from Hedley, 1915); FIG. 12: Silicula fragilis Jeffrey, 1879 (type species of Silicula) (NMW, image number M011725, from Marine Bivalve Shells of the British Isles web site (Oliver et al., 2010)). Scale bar = 1 mm.

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parallel to each other; a broad thickening ofthe hinge plate under the beak, in which an oblique resilifer is located (Bernard, 1989; Coan et al., 2000; Figs. 13-16). These peculiarities of the shell morphology and the hinge structure of S. sandersi correspond much more to the diag-nosis of the genus Lamellileda (Cotton, 1930; Ludbrook, 1961; Heinberg, 1989; Table 1). The

type species of this genus, Lamellileda typica Cotton, 1930, has analogous proportions oft he shell, numerous relatively short lamellate pos-
terior teeth becoming posteriorly shorter and
oblique to the dorsal shell margin, and short
lamellate horizontal anterior teeth not parallel
to the anterodorsal shell margin (Cotton, 1930
Figs. 2, 3). Therefore, | share the Huber’s

FIGS. 13-24. Silicula sandersi (Bernard, 1989) and Propeleda soyomaruae (Okutani, 1962). FIGS. 13-16: S. sandersi, holotype (LACM 2348), exterior and interior views of right and left valves, shell length 11.2 mm
17-21: Holotyp

photos by L. T. Groves and P. Valentich Scott); FIGS. 17-24: P. soyomaruae. FIGS:
e (NSMT Mo 62762), exterior and interior views of right valve, anterior and posterior
sets of teeth, resilifer, shell length 20.0 mm; FIGS. 22-24: Paratype (NSMT Mo 49827), exterior view of left valve, posterior teeth, length of shell fragment 18.0 mm.

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(2010) viewpoint that Bernard (1989) correctly referred S. sandersito Lamellileda and exclude
this species from comparative analysis with
other species of the genus Silicula.
Bernard (1989) remarked that L. sandersi is
most close to Р soyomaruae. Okutani (1962) described Р soyomaruae from only one speci-men found in the northwestern Pacific at the coast of Japan at a depth of 730-760 m. He originally placed this species in the genus Poroleda Hutton, 1893, with the type species Poroleda lanceolata (Hutton, 1885), which has numerous oblique lamellate teeth in the posterior set and V-shaped teeth in the anterior (Hedley, 1905; Heinberg, 1989; Table 1; Figs. 6-9). Later, Okutani (2000) transferred this spe-cies to the genus Propeleda Iredale, 1924, with the type species Propeleda ensicula (Angas, 1877) (Iredale, 1924). However, P ensicula has V-shaped posterior and anterior teeth and only a few lamellate posterior teeth closest to beak (Angas, 1877; Hedley, 1915; Nijssen-Meyer, 1972; Heinberg, 1989; Figs. 10, 11). In contrast to P. ensicula, both anterior and posterior teeth in Р soyomaruae are lamellate (Figs. 17-24). The proximal posterior teeth are the longest and almost parallel to the posterodorsal shell margin, while posterior distal teeth are shorter and located diagonally across the hinge plate. The anterior teeth are subequal in length, horizontal, parallel to each other, the hinge plate under the beak is markedly thickened to harbor an oblique resilifer directed posteroven-trally. Thus, the shell shape and proportions and the hinge structure of P. soyomaruae are very similar to those of L. typica, but not P ensicula. Therefore, Huber (2010) referred Р. soyomaruae to the genus Lamellileda. | agree with the Huber’s (2010) opinion that P. soyo-maruae should be recognized as a species of Lamellileda. Taking into account the marked differences in the shell shape and proportions, as well as in the habitat depth, it can be sug-gested with a high degree of probability that Lamellileda soyomaruae (Okutani, 1962) and L. sandersi are different species, though the differences in the shell morphology may be due to the age variation, because the holotype of L. soyomaruae is 20.0 mm long, while the ho-lotype of L. sandersi is 11.2 mm long (Okutani, 1962; Bernard, 1989). Lamellileda soyomaruae is much closer in shell morphology and habitat depth to L. typica. However, further investiga-tions of the type and additional material are needed to make valid conclusions about the relationships of these species.

Silicula beringiana
Kamenev, n. sp.
(Figs. 25-70, 72, Table 2)

Type Material and Locality

Holotype (ZMMU Ld-3052), Bering Island, Commander Islands, Bering Sea (55°36.1’N, 167°23.04’E-55°35’N, 167°24.5’E), 4,294— 4,200 m, Sigsbee trawl, Coll. L. |. Moskalev, 05-VIII-1990 (R/V “Akademik Mstislav Keldysh”, cruise 22, stn. 2316); paratypes
(40) (ZMMU Ld-3053 (30 paratypes), MIMB 28313 (10 paratypes)) from holotype locality; paratypes (20) (MIMB 28314), Bering Island, Commander Islands, Bering Sea (55°13.2’N, 167° 29.0 2ES55,.12202’N,, 467° 26-7 E), 3,957-3,978 m, Sigsbee trawl, Coll. L. |. Moskalev, 31-VII-1990 (R/V “Akademik Ms-tislav Keldysh”, cruise 22, stn. 2309).

Other Material Examined

960 specimens (IO RAN) from holotype local-ity; 71 specimens (10 RAN), Bering Island, Commander Islands, Bering Sea (55°13.2’N, 107729.011E=55"12.02N. 167267E) 3,957-3,978 m, Sigsbee trawl, Coll. L.l. Moskalev, 31-VII-1990 (R/V “Akademik Ms-tislav Keldysh”, cruise 22, stn. 2309); one damaged specimen (10 RAN), Bering Island, Commander Islands, Bering Sea (55°23.8'N, 167°15.52’E), 489 m, manned submersible “Ми-|”, Coll. L.I. Moskalev, 7-VIII-1990 (R/V “Akademik Mstislav Keldysh’, cruise 22, stn. 2320); two damaged specimens (IO RAN), Bering Island, Commander Islands, Bering Sea (55°22.3'N, 167°18.8’E-55°21,8N , 167°18'E), 1,490-1,554 m, dredge, Coll. L. I. Moskalev, 8-VIII-1990 (R/V “Akademik Mstislav Keldysh”, cruise 22, stn. 2321); one damaged specimen (10 RAN), Ber-ing Island, Commander Islands, Bering Sea (55°32.2’N, 167°16.76 E-55°31.37'N, 167°16.2’Е), 3,446-3,313 m, dredge, Coll. L. I. Moskalev, 7-VIII-1990 (R/V “Akademik Mstislav Keldysh”, cruise 22, stn. 2318); 4 damaged specimens (10 RAN), Bering Sea (57°03’М, 168°30’E), 3,875 m, Sigsbee trawl, 25-1X-1950 (R/V Vityaz”, cruise 5, stn. 618); 5 specimens (10 RAN), Kamchatsky Strait, Bering Sea (55°52’N, 164°08’E), 4,382 m, Sigsbee trawl, 17-IX-1950 (R/V “Vityaz’, cruise 5, stn. 524); one damaged specimen (IO RAN), Kamchatsky Strait, Bering Sea (55°39’N, 164°31’E), 4,811 m, Okean grab,

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28-IX-1951 (R/V “Vityaz”, cruise 8, stn. 956a); one specimen (IO RAN), southeast-ern Kamchatka, Pacific Ocean (53°05.4’N, 161°55.2’E-53°20.7’N, 161°56.1’E), 4,890- 4,984 m, Sigsbee trawl, Coll. 1..1. Moskalev, 10-VIII-1990 (R/V “Akademik Mstislav Keldysh”, cruise 22, stn. 2323). Total of 1,046 specimens.

Description

Exterior. Shell small (to 14.7 mm), elongate (H/L = 0.486 + 0.003), equivalve, inequilateral, gaping anteriorly and posteriorly, flattened (W/L = 0.204 + 0.003), thin, fragile, translucent in young specimens (L < 9 mm). Surface with very thin, dense, commarginal ribs, well defined along the ventral margin and sparse radial rays

formed by densely spaced short concentric riblets most expressed at the anterior shell end. Periostracum thin, adherent, yellow-green. Beaks small, very low, slightly prominent above dorsal shell margin, rounded, prosogyrate, an-terior to midline (A/L = 0.347 + 0.002). Anterior shell end rounded, angular. Posterior shell end extended, tapered, truncated, with long, week flexure and shallow sulcus extending from beaks to posterior shell margin. Dorsal shell margin anteriort o posterior and to beaks forming very small concavities. Anterodorsal shell margin strongly convex, often forming a
smooth angle, rather sharply descending, and
almost straight in lower portion. Anterior shell
margin rounded, often forming a weak rounded
angle. Posterodorsal shell margin straight,
sometimes slightly convex or concave, form-

FIGS. 25-37. Silicula beringiana Kamenev, п. sp. FIGS. 25-27: Holotype (ZMMU Ld-3052), exterior and dorsal views of both valves, shell length 13.7 mm; FIGS. 28-37: Shells of different age specimens. FIG. 28: Paratyp e (ZMMU Ld-3053), dorsal view of both valves, shell length 11.0 mm; FIG. 29: Paratype (ZMMU Ld-3053), shell length 14.7 mm; FIG. 30: Specimen from holotype locality, shell length 14.2 mm; FIG. 31: Paratype (ZMMU Ld-3053), shell length 12.6 mm; FIG. 32: Paratype (ZMMU Ld-3053), shell
length 13.5 mm; FIG. 33: Paratyp e (ZMMU Ld-3053), shell length 10.9 mm; FIG. 34: Paratype (ZMMU Ld-3053), shell length 7.8 mm; FIGS. 35, 36: Paratype (ZMMU Ld-3053), exterior view of left and right valves, shell length 8.7 mm; FIG. 37: Specimen from holotype locality, shell length 4.3 mm.

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TABLE 2. Silicula beringiana Катепех, п. sp. Shell measurements (mm), indices and summary statistics of characters, п = 65, size range of shells used 5.0 to 14.7 mm; L —
shell length; H — height; W — width; A - anterior end length.

Depository L H

Holotype ZMMU Ld-3052 13.7 6.2
Paratype ZMMU Ld-3053 14.7 6.6
Paratype ZMMU Ld-3053 13.3 622
Paratype ZMMU Ld-3053 12.8 6.0
Paratype ZMMU Ld-3053 12.3 6.1
Paratype ZMMU Ld-3053 12.6 6.0
Paratype ZMMU Ld-3053 12.3 6.0
Paratype ZMMU Ld-3053 12.0 6.0
Paratype ZMMU Ld-3053 11.4 5:8
Paratype ZMMU 19-3053 9.9 Se
Paratype ZMMU Ld-3053 8.5 4.0
Paratype ZMMU Ld-3053 8.0 3.9
Paratype ZMMU Ld-3053 7.8 4.0
Paratype ZMMU Ld-3053 7.3 IT
Paratype ZMMU Ld-3053 6.5 109)
Paratype ZMMU Ld-3053 5.6 29

Statistics le H

Mean - -
SE - -
$0 - -
Min - -
Max : -

ing a distinct, weakly rounded obtuse angle at transition to posterior shell margin. Posterior shell margin short, straight or slightly convex, vertical or directed slightly posterior, forming a distinct, weakly rounded angle at transition to ventral shell margin. Ventral shell margin gently curved. Prodissoconch small (length 190-207 um), D-shaped, distinctly marked, with net-like, cellular sculpture.

Interior: Hinge plate narrow, long, slightly curved. Teeth divided into anterior and posterior sets by small, edentulous gap of hinge plate with resilifer. Internal ligament opisthodetic, well developed, large, elongate, oblique, posterior to beaks. Resilifer elongate, narrow, oblique, extending posteriorly (somewhat into shell) from beak to almost end of first posterior tooth. In adult specimens (L > 9 mm) anterior teeth set of 5 teeth, posterior one 5-6. Anterior teeth

A W H/L A/L W/L

4.3 Lal 0.453: 0.514 0519
5.0 3.4 0.449 0.340 0.231
4.9 2.4 0.466 0.368 0.180
4.5 20 0.469 0.352 0.180
4.2 23 0.496 0.341 0.203
39 2.6 0.476 0.310 0.206
4.1 29 0:485:..00:333773:0:203
4.0 2.4 0.900033 20200
4.0 2.3 OCI Oise 1? 0202
3 2.0 UNS SN 10202
3.0 1:6 0.471 0.353 0.188
2.7 1.6 0.488 0.338 0.200
27 dee 0.512 0.346 0.231
2% 127 0.307. 0270 0253
2.4 (ES 0.595 20569770200
22 1.0 Pte.” 709937 OS

A W H/L A/L W/L

- - 0.486 0.347 0.204
- - 0.903 7701002 ~ 02003
- - 0.0237720:0207%:020209
- - 0.440 0.304 0.155
- - WS US. 09243

narrow, long, overlapping each other, almost parallel to anterodorsal shell margin, becoming longer towards anterior shell margin, except last short tooth. First anterior tooth slightly concave, thinnest, low, arising from dorsal margin of hinge plate under beak; teeth 2-4 much longer, highest, slightly convex, arising from ventral margin of hinge plate; tooth 5 short, weakly expressed, lowest, positioned almost entirely under tooth 4. Posterior teeth narrow, longer than anterior teeth, overlapping each other, almost parallel to posterodorsal shell margin, becoming longer towards poste-rior shell margin, except last short tooth. First posterior tooth concave, thinnest, low, located above resilifer, arising from dorsal margin of hinge plate under beak. Second tooth 2-2.5 times longer than first, slightly concave, arising from hinge plate above resulifer and partially forming posterodorsal margin of resilifer. Third

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tooth straight, arising from ventral margin of hinge plate at posterior resilifer end. Teeth 4-5 straight, longest, arising from ventral margin of hinge plate. Sixth tooth short, weakly ex-pressed, low, positioned almost entirely under tooth 5, present only in largest specimens. Ад-ductors scars weakly visible, unequal; anterior adductor scar larger than posterior. Anterior adductor scar slightly elongated, almost verti-cally extended, positioned under anterior end of hinge plate. Posterior adductor scar slightly elongated, oblique, positioned under posterior end of hinge plate. Pallial line extending beyond posterior adductor scar, forming distinct shallow pallial sinus not confluent with pallial line; sinus apex not extending beyond anterior margin of posterior adductor scar.

Anatomy: Mantle very thin, except thickened ventral margin. Exhalant siphon long. Adductor muscles slightly oval, oblique; anterior muscle larger than posterior, more vertically extended. Food large, with a large anterior toe and a small posterior heel; toe with numerous papillae of varying size. Posterior pairs of pedal retrac-tors large, wide, passing anterior to posterior adductor muscle. Three anterior pairs of pedal retractor muscles narrow, long, passing be-tween anterior adductor muscle and stomach. Gills long, narrow, almost horizontal, extending
from ventral side of stomach to ventral side of
posterior adductor muscle; gill filaments short.
Palps very long, with about 40 ridges, almost
parallel to ventral shell margin, positioned
close to ventral shell margin. Palp proboscides

FIGS. 38-44. Silicula beringiana Kamenev, п. sp. FIGS. 38-40: Interior view, hinge plate, and internal ligament of right valve of specimen from holotype locality, shell length 11.4 mm; FIGS. 41-44: Exterior view, sulcus of posterior shell end, sculpture of anterior shell end, beak of right valve of specimen from holotype locality. Scale bars = 500 um.

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relatively short in contacted state. Mouth in central part of mantle cavity. Oesophagus long, displaced to right side of body, passing behind anterior adductor muscle and along antero-dorsal shell margin forming a large uniformly rounded bend. Stomach large, oval, lying under beak along dorsoventral axis. Combined style sac and midgut leaving stomach at posteroven-tral border, directed almost vertical, passing into foot; midgut usually with one or two small bends. Hindgut penetrating deep into foot heel, forming a short loop into ventral part of heel, turning dorsally, slightly curving behind style sac and passing in right side of body. In right

side of body hindgut sharply bending backward, turning forward and passing under beak into left side of body. In left side of body hindgut form-ing a large loop and passing under the beak backward into right side of body. Here hindgut forming a large (about two times diameter of loop in left side) oval loop corresponding to shape and size of stomach, turning posteriorly under and passing along posterodorsal shell
margin above posterior adductor muscle to
anus. Digestive diverticula surrounding anterior
adductor muscle, oesophagus, stomach, par-
tially labial palps and gills, reaching posterior
pedal retractors.

FIGS. 45-53. Silicula beringiana Kamenev, n.sp. Left valve of specimen from holotype locality. FIGS. 45-47: Interior view, hinge plate, and resilifer; FIGS. 48-51: Posterior (ventral and dorsal views) and an-terior sets of teeth; FIGS. 52, 53: Prodissoconch. Scale bars: Fig. 45 = 1 mm, Figs. 46-53 = 200 um.

TWO NEW SPECIES OF SILICULA 265

FIGS. 54-69. Silicula beringiana Kamenev, n. sp. FIGS. 54-63: Interior morphology of left valve of young specimen from holotype locality; FIGS: 54-57: Internal view of valve, ventral view of hinge plate and resilifer, dorsal view of hinge plate; FIGS. 58—60: Posterior (ventral and dorsal views) set of teeth; FIGS. 61-63: Anterior (ventral and dorsal views) set of teeth; FIGS. 64-69: Interior morphology of left and right valves of adult specimen from holotype locality. FIGS. 64-67: Internal view, posterior teeth, ventral view of posterior teeth, resilifer of left valve; FIGS. 68, 69: Internal view and posterior teeth of right valve. Scale bars: Figs. 54, 64, 68 = 1 mm, Figs. 55-63, 65-67, 69 = 200 um.

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Variability

Silicula beringiana exhibits large indi-
vidual and age variations in shell shape and proportions. In young specimens (Ё < 8 mm),
the shell is higher (H/L > 0.5), the beaks are positioned closer to the middle of the shell (A/L > 0.36) and the posterior shell margin is directed vertically down. In specimens larger than 8 mm, the shell is relatively more elon-gate, the beaks are more displaced anteriorly, the rostrum is narrower, often slightly curved

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upward, thus making the posterodorsal margin concave, the posterior shell margin is oblique, directed posteriorly. In adult specimens (L > 8 mm), the shell height and width vary markedly (H/L = 0.444—0.521; W/L = 0.155-0.243), the posterodorsal shell margin may be straight or concave. The hindgut in the right side of
the body also varies in size. The length of
the gut loop in the right side is about 2 times
usually greater than in the left but sometimes
the loops in both sides of the body are about
the same length.

FIGS. 70, 71. Silicula beringiana Kamenev, п. sp., and Silicula okutanii Kamenev, п. sp. Internal morphology as seen from right side with right shell, mantle, and parth of the body removed. FIG. 70: Silicula beringiana Катепех, п. sp.; FIG. 71: Silicula okutanii Kamenev, п. sp. Scale bars = 1 mm. Abreviations: a, anus; aa, anterior adductor muscle; apr, anterior pedal retractors; dd, digestive diver-ticula; em, edge of mantle; es, exhalant siphon; f, foot; g, gill; hg, hindgut; oe, oesophagus; p, palp; pa, posterior adductor muscle; pp, palp proboscis; ppr, posterior pedal retractor; s, stomach.

TWO NEW SPECIES OF SILICULA 267

pa hg s oe aa

FIG. 72. Diagram of gut of Silicula beringiana and Silicula okutanii as seen from dorsal side. Abreviations: aa, anterior adductor muscle; h, hindgut; oe, oesophagus; pa, posterior adductor muscle; s, stomach.

Sea of Okhotsk $

Distribution and Habitat (Fig. 73)

This species was recorded in the Bering Sea (Commander Basin) at a depth from 489 m (55°23.8'N, 167°15.52’E) to 4,294 m (55°36.1’N, 167°23.04’E); in Kamchatsky Strait, Bering Sea, at 4,382 m (55°52’N, 164°08’E) to 4,811 m (55°39’М, 164°31’E); off southeastern Kamchat-ka, Pacific Ocean, at 4,890-4,984 m (53°05.4N, 161852 E-53°20.7' N, 161°58. TE).

Comparisons

Silicula beringiana is easily distinguished from S. fragilis, S. filatovae, S. rouchi and S.
alleni in having a highly elongated shell with
the posterior end produced like a rostrum and

Commander
Islands

Pacific Ocean

FIG. 73. Distribution of Silicula beringiana and Silicula okutanii. e $. beringiana (о type locality), m $. okutanii (no type locality).

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truncated (Figs. 74-85, Table 3). According to
shell shape and proportions, this species is
most close to $. patagonica and $. mcalesteri,
which have an elongate shell with a produced
and truncated posterior end. Adult specimens
of S. beringiana well differ from S. mcalesteri in having a more flattened (W/L 5 mcalesteri = 0.27; WIL $. beringiana = 0.204) (Allen & Sanders, 1973), nontransparent, thicker shell with the beaks less displaced anteriorly, a more rounded anterior end and a straight or concave posterodorsal margin, no more than 6 instead of 8 posterior teeth in the hinge, a far smaller prodissoconch, and two large loops of the gut in both sides of the body but not one loop only in the right side (Figs. 86-88).
A fairly complete comparison of S. beringi-ana and S. patagonica is hindered because the holotype of S. patagonica is represented merely by one damaged valve 8.4 mm long (Dall, 1908; Fig. 89, 90). Judging from the position of the inner pit, which is under the beak (Dall, 1908), the beak of $. patagonica is much more displaced anteriorly compared to $. beringi-ana. In the figure and photo of the valves of $. patagonica with a shell length of 9.8 and 8 mm provided in works of Dell (1990) and Villarroel & Stuardo (1998), the position of the beaks nearly corresponds to that in S. beringiana. However, large specimens of $. beringiana (larger than 9 mm), unlike $. patagonica, have a more elongate shell with a narrow and trun-cated posterior end and a straight or concave posterodorsal margin (Table 3).

Etymology

The species name “beringiana” derives from the name of the Bering Sea, where almost en-tire material of this species was collected.

Remarks

Allen & Sanders (1973) noted that in contrast to the close genera Poroleda and Propeleda, representatives of the genus Silicula have a slightly convex or straight, but not concave posterodorsal shell margin. Nevertheless, adult specimens of S. beringiana, S. fragilis and S. rouchi often have a slightly concave postero-dorsal shell margin (Figs. 74—79). Therefore, | think that the lack of concavity in the postero-dorsal shell margin is an erroneous distinctive character of the genus Silicula.
Allen & Sanders (1973) showed that the shell of Silicula species investigated by them elon-gates as it grows. This elongation is largely pos-

terior growth oft he shell. Similarly, shell shape and proportions in S. beringiana change as its shell grows. In juvenile specimens, the shell is less elongate and the beaks are located closer to the middle of the shell. As the shell size increases, the posterior shell end elongates, the rostrum becomes narrower, slightly curves upwards, and the beaks, correspondingly, are displaced anteriorly.
Due to the transparent shell of S. filatovae and S. mcalesteri, Allen & Sanders (1973) were able to determine the degree of development of the gonad through the shell. Specimens of S. beringiana larger than 9 mm have an opaque shell. Therefore, the shells of specimens of varying size from stations 2309 and 2316 were opened for the study of the gonads. However, it was not possible to determine the sex in all the specimens because the gonads were immature.
Silicula beringiana was found at depths of 489-4 ,984 т. At present, this is the largest depth range for Silicula species. S. patagonica, S. rouchi and $. mcalesteri were only recorded in the shelf and bathyal zones at depths of 135 to 1,153 m (Dall, 1908; Lamy, 1910, 1911; Dell, 1964, 1990; Allen & Sanders, 1973; Egorova, 1982; Villarroel & Stuardo, 1998; D. G. Zelaya, personal communication). Silicula fragilis was found from the lower bathyal to abyssal zone (1,493-4,402 m), S. alleni (3650 m) and S. filatovae (3,826-5,042 m) in the abyssal zone (Allen & Sanders, 1973; Bernard, 1989). Almost all specimens of S. beringiana were discovered in the deep-sea basin ofthe Bering Sea and in the deep-water Kamchatsky Strait connecting the Bering Sea and the Pacific Ocean. Only one specimen of this species was found in the Pacific Ocean to the south ofthe Kamchatsky Strait. However, 5 strongly damaged specimens of siliculids that closely resemble $. beringiana were taken at a depth of 4,180 m in the Pacific Ocean south of Unimak Island (53°25’0N, 163°23’0W, Aleutian Islands, U.S.A.). It is therefore very likely that further studies will reveal S. beringiana in other regions of the North Pacific.
At stations 2316 and 2309 (R/V “Akademik Mstislav Keldysh”, cruise 22), conducted at maximum depths (3,957-4,294 m) of the Bering Sea, S. beringiana was found in very large numbers. This species comprised more than 50% of the total number of all bivalve specimens in the sample. Therefore, it can be stated that S. beringiana is one of the domi-nant species of bivalves at maximum depths of the deep-water basin of the Bering Sea.

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FIGS. 74-90. Species of the genus Silicula. FIGS. 74-76: Silicula fragilis, exterior view of right valve (NWM, image number M011727), interior view of right valve (NWM, image number M011725), exterior view of left valve (NWM, image number M011726). Photos from Marine Bivalve Shells of the British Isles web site (Oliver et al., 2010); FIGS. 77-79: Silicula rouchi, interior view of right valve (photo by D. G. Zelaya), exterior and interior views of left valve (USNM 870326). Photos from USNM Web site, “Information provided with the permission of the National Museum of Natural History, Smithsonian Institution, 10th and Constitution Ave. N.W., Washington, DC 20560-0193 (http://www.nmnh.si.edu/)”; FIGS. 80-82: Silicula alleni, holotype (LACM 2344), exterior and interior views of right valve, interior view of left valve, shell length 8.6 mm. Photos by L. T. Groves and P. Valentich-Scott; FIGS. 83-85: Silicula filatovae. FIGS. 83, 84: Holotype (MCZ 271977); FIG. 85: Paratype (MCZ 361653). Photos by A. J. Baldinger from MCZ Web site, “President and Fellows of Harvard Colledge”; FIGS. 86-88: Silicula mcalesteri. FIGS. 86, 87: Holotype (MCZ 271974); FIG. 88: Paratype (MCZ 361654). Photos by A. J. Baldinger from MCZ Web site, “President and Fellows of Harvard Colledge”; FIGS. 89, 90: Silicula patagonica, holotype (USNM 96914). Photos from USNM Web site, “Information provided with the permission of the National Museum of Natural History, Smithsonian Institution, 10th and Constitution Ave. N.W., Washington, DC 20560-0193 (http://www.nmnh.si.edu/)”. Scale bars = 1 mm.

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Silicula okutanii
Kamenev, n. sp.
(Figs. 71, 91-119, Table 4)

Type Material and Locality

Holotype (MIMB 28315), Pacific Ocean (40°13.33’М, 148°6.48’E-40°12.53’N, 148°5.76E), 5,348-5,347 m, Agassiz trawl, Coll. С. M. Kamenev, 30-VIII-2012 (R/V “Sonne”, cruise 223, stn. 11-10); paratypes
(3) (MIMB 28316), Pacific Ocean (40°13.10’N, 148°6.45°’E-40°12.10’N, 148°5.53’E), 5,351— 5,348 m, epibenthic sledge, Coll. G. M.

Other Material Examined

Two specimens from holotype locality; 8 speci-mens (MIMB 28317), Pacific Ocean (39*43.80'N, 147°10.16E-39°42.49'N, 147°9.37’E), 5,224— 5,215 m, epibenthic sledge, Coll. G. M. Kame-nev, 1-1Х-2012 (R/V “Sonne”, cruise 223, stn. 12-4); 2 specimens (MIMB 28318), Pacific Ocean (39°43.47’N, 147°10.11’E-39°42.54'N, 147°9.51’E), 5,229-5,217 m,A gassiz trawl, Coll. С. M. Kamenev, 1-IX-2012 (R/V “Sonne”, cruise 223, stn. 12-5); 2 specimens (MIMB 28319), Pacific Ocean (39°43.43'N, 147°9.98’E), 5,243
m, boxcorer, Coll. G. M. Kamenev, 31-VIII-2012
(R/V “Sonne”, cruise 223, stn. 12-2). Total of
18 specimens.

Kamenev, 31-VIII-2012 (R/V “Sonne”, cruise
223, sin 11-12),

TABLE 4. Silicula okutanii Kamenev, sp. nov. Shell measurements (mm), indices and
summary statistics of characters, n = 17, size range of shells used 7.1 to 11.8 mm:
L — shell length; H — height; W — width; A — anterior end length.

Depository E H A W H/L AL W/L

Holotype MIMB 28315 11.7 4.8 3.4 22 0.410 0.291 0.188
Paratype MIMB 28316 11.6 4.7 3.4 1.8 04050293. 0:195
Paratype MIMB 28316 11.1 4.5 32 1.8 0.405 + 0288 09162
Paratype ММВ 28316 8.1 16 Zo ES 0.444 0.309 0.160
MIMB 28317 11.8 4.9 3.5 2.0 0,415 0,297 . 20169
MIMB 28317 10.8 4.5 3.3 8 0.417 0.306 0.148
MIMB 28317 10,3 4.2 3.0 148 0.408 0.291 0.146
MIMB 28317 9.6 4.0 2.8 ME 0.417 0.292 0.156
MIMB 28317 9.6 3:9 2.8 1:6 0.406 0.292 0.167
MIMB 28317 8.9 3.7 2.6 1.4 0.416 0.292 0.157
MIMB 28317 8.8 3.5 2.6 1.4 0.398 0.295 0.159
MIMB 28317 8.5 3.6 2.6 1.3 0.424 0.306 0.153
MIMB 28319 8.5 +0 2,5 тэ 0.412 0.294 0.153
МИМВ 28319 8.1 3.4 2.4 1.6 0.420 0.296 0.198
MIMB 28320 8.0 3.4 2.4 1.6 0.425 0.300 60.200
МИМВ 28320 1.8 3 28 1.4 0.297. 0295 0179
MIMB 28318 Fall 3.0 24 1.1 0423 0296 0.155

Statistics je H A W H/L A/L W/L

Mean - - - - 0.414 0.296 0.165
SE - - - - 0.00% 0.004 0.004
SD - - - - 0.041. 0005. О
Min - - - - 0,397... 0.288 0,146

Max - - - - 0.444 0.309 0.200

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FIGS. 91-107. Silicula okutanii Kamenev, п. sp. FIGS. 91-93: Holotype (ММВ 28315), exterior and dorsal views of both valves, shell length 11.7 mm; FIGS. 94-107: Shells of different age specimens. FIG. 94: Exterior view of left valve of specimen (MIMB 28320) from holotype locality, shell length 8.0 mm; FIG. 95-107. Specimen (MIMB 28320) from holotype locality, shell length 7.8 mm. FIGS. 95, 96: Exterior view of left and right valves; FIGS. 97-99: Exterior and interior views of left valve; FIGS. 100-107: Hinge plate, dorsal view of beak, anterior (ventral and dorsal views) and posterior (ventral and dorsal views) sets of teeth. Scale bars: Figs. 97, 99 = 1 mm, Figs. 98, 100-107 = 200 um.

TWO NEW SPECIES OF SILICULA >

Description

Exterior. Shell small (to 11.8 mm), very elon-gate (H/L = 0.414 + 0.003), equivalve, strongly inequilateral, gaping anteriorly and posteriorly, very flattened (W/L = 0.165 + 0.004), very thin, fragile, transparent. Surface with very thin, dense, commarginal ribs, best defined along ventral margin and sparse radial rays formed by densely spaced short concentric riblets most expressed at anterior shell end. Periostracum thin, adherent, yellow-green. Beaks small, very low, slightly prominent above dorsal shell margin, rounded, prosogyrate, strongly anterior to midline (A/L = 0.296 + 0.001). Anterior shell end smoothly rounded. Posterior shell end very extended, tapered, truncated, with long, very week flexure and shallow sulcus extending from beaks to posterior shell margin. Dorsal shell margin anterior to posterior to beaks forming very small concavities. Anterodorsal shell mar-gin slightly convex, almost horizontal, smoothly transitioning to anterior shell margin. Anterior shell margin smoothly rounded. Posterodorsal shell margin slightly convex, forming a distinct, rounded obtuse angle at transition to poste-rior shell margin. Posterior shell margin short, straight or slightly convex, directed slightly posterior, forming a distinct, weakly rounded angle at transition to ventral shell margin. Ven-tral shell margin gently curved. Prodissoconch small (length 193-227 um), D-shaped, distinctly marked, with net-like, cellular sculpture.

Interior. Hinge plate narrow, long, slightly curved. Teeth divided into anterior and posterior sets by small, edentulous gap of hinge plate with resilifer. Internal ligament opisthodetic, well developed, large, elongate, extending pos-teriorly from beaks. Resilifer elongate, narrow, oblique, directed posteriorly (Somewhat into shell) from beaks to almost end of first posterior tooth. Anterior teeth set of 5-6 teeth, posterior one 6-7. Anterior teeth narrow, long, overlap-ping each other, almost parallel to anterodorsal shell margin, becoming longer towards anterior shell margin, except very short last tooth in larg-est specimens. First anterior tooth slightly con-cave, low, thinnest, arising from dorsal margin of hinge plate under beak; teeth 2-5 by far lon-ger, highest, straight or slightly convex; tooth 6 shortest and lowest, weakly expressed, located almost entirely under tooth 5. Second tooth, like first tooth, arising from dorsal margin of hinge plate under beak. Teeth 3—6 arising from ventral margin of hinge plate. Posterior teeth narrow,

longer than anterior teeth, overlapping each other, parallel to posterodorsal shell margin, almost horizontal, becoming longer towards posterior shell margin, except last short tooth. First posterior tooth slightly concave, thinnest, low, located under resilifer, arising from dorsal margin of hinge plate under beak. Second tooth 2—2.5 times longer than first tooth, slightly con-cave, arising from dorsal margin of hinge plate under beak, partially forming posterodorsal margin of resilifer. Tooth 3 straight, extending from ventral margin of hinge plate at posterior resilifer end. Teeth 4—6 straight, longest, aris-ing from ventral margin of hinge plate. Tooth 7 straight, short, weakly expressed, low, almost entirely located under tooth 6, present only in largest specimens. Adductors scars weakly visible, unequal; anterior adductor scar larger than posterior. Anterior adductor scar slightly elongated, almost vertically extended, located under anterior end of hinge plate. Posterior adductor scar highly elongated, almost hori-zontally extended, located under posterior end of hinge plate. Pallial line extending beyond posterior adductor scar, forming a very shallow pallial sinus, not confluent with pallial line; sinus apex reaching to middle of ventral margin of posterior adductor scar.

Anatomy: Internal morphology similar to that of S. beringiana. Mantle very thin, except thickened ventral margin. Exhalant siphon very long. Both adductor muscles oval, elongated; anterior muscle larger than posterior, oblique, directed anterodorsally; posterior muscle ex-tending almost horizontally. Foot large, with a large anterior toe and a small posterior heel; toe with numerous papillae of varying size. Posterior pairs of pedal retractors large, wide, passing anterior to posterior adductor muscle. Three anterior pairs of pedal retractor muscles narrow, long, running between anterior adduc-tor muscle and stomach. Gills long, narrow, almost horizontal, extending from ventral side of stomach to ventral side of posterior adductor muscle; gill filaments short. Palps short, with 20 palp ridges, almost parallel to ventral shell margin, occupying central part of mantle cavity. Palp proboscides very long in contracted state. Mouth located in central part of mantle cavity. Oesophagus long, displaced to right side of body, passing posterior to anterior adductor scar and along anterodorsal shell margin, form-ing a large uniformly rounded bend. Stomach large, globular, lying in space under beaks, along dorsoventral axis. Combined style sac

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and midgut leaving stomach at posteroventral border, passing ventrally into foot. Hindgut penetrating deep into foot heel, forming a
short loop, turning dorsally, passing posterior
to style sac in right side of body. In right side
of body hindgut forming a broad and smooth curve posterodorsally, then sharply curving ventrally, passing under beaks into left side of body. In left side of body, hindgut forming a

rounded loop, passing under beaks backward to right side of body. Here hindgut forming a large rounded loop corresponding to stomach size, turning posteriorly under beak and pass-
ing along posterodorsal shell margin above
posterior adductor muscle to anus. Diges-
tive diverticula surrounding anterior adductor
muscle, oesophagus, stomach, partially labial
palps and gills.

FIGS. 108-119. Silicula okutanii Kamenev, п. sp. Interior morphology of left valve of adult specimen (ММВ 28317), Pacific Ocean (39°43.80’М, 147°10.16’E-39°42.49’N, 147°9.37°E), 5,224-5,215 m. FIGS: 108-110: Internal view of valve, ventral and dorsal views of hinge plate; FIGS. 111-113: Anterior (ventral and dorsal views) set of teeth; FIGS. 114—116: Posterior (ventral and dorsal views) set of teeth; FIGS: 117-119: Resilifer, prodissoconch, dorsal view of beak. Scale bars: Figs. 108-110 = 1 mm, Figs. 111-119 = 200 um.

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TABLE 5. Results of comparison by pairs of mean values (T-test) and variances (ANOVA) of indices of the shells of Silicula beringiana and Silicula okutanii: L— shell length; A- anterior end length; H — height; W — width; P — probability that index values in S. beringiana and S. okutanii are drawn from the same population; п — number of valves of compared species, respectively; * — significant difference.

Indices T-test ANOVA
T Р Е т n

MIE 21767 = 0,001 10466" ЗАЛЕ" 17:67 HE 160,000 149,430 H/L* 17.89 WI/L* 827 "0004 164.22 NL 8.27

Variability

The shell shape and proportions of S. oku-tanii little changes with age. In most of young specimens (L < 9 mm), the shell is slightly higher (H/L = 0.412-0.444) with beaks less displaced anteriorly (A/L = 0.294-0.309), compared to specimens with a shell length more than 10 mm (H/L = 0.405-0.417; A/L = 0.288-0.306). However, some young specimens had the same shell proportions as in adult specimens. Specimens with a length less than 7 mm were lacking in the examined material. It is possible that more distinct differences in shell shape may be found between juvenile and adult speci-mens. Adult specimens show slight variations of shell height, relative position of beaks, and the degree of convexity of the posterodorsal shell margin (sometimes almost straight).

Distribution and Habitat (Fig. 73)

This species was recorded in the northwest-ern Pacific at a latitude of the northern part of Japan at 5,219-5,352 m depth (bottom tem-perature 1.6°C, salinity 34.7%o).

Comparisons

Like S. beringiana, S. okutanii is readily dis-tinguished from S. fragilis, S. filatovae, S. rouchi and S. alleni in having a strongly elongate shell with its posterior end extended in the form of a rostrum and truncated (Figs. 74-85). Silicula okutanii is most close in shell shape and pro-portions to S. patagonica, S. mcalesteri and S. beringiana, which also have elongate shells with extended and truncated posterior end

(Figs. 25-69, 86-90). However, in contrast to these three species, $. okutanii has a markedly lower and elongate shell with more extended and tapering posterior end (Table 3). Further-more, S. okutanii differs from S. mcalesteri in having a thinner and more flattened shell (W/L y mcalesteri — 0.27; W/L $. okutanii = 0.1 65) with more rounded and more extended anterior end, much smaller prodissoconch, fewer posterior teeth in the hinge, almost horizontal position of the pos-terior adductor muscle, the presence of large intestinal loops in both sides of the body, but not one loop in the right side (Allen & Sanders, 1973). Compared to S. patagonica, the shell of S. okutanii, in addition to the differences in shape and proportions, is thinner, translucent and the apex of the pallial sinus does not project beyond posterior adductor scar.
Silicula okutanii is most close to S. ber-ingiana, from which it differs in its more flat-tened and elongate shell with more extended posterior end and more rounded anterior end. Mean values and variances of the indices characterizing the position of beaks (A/L), the relative height (H/L) and width (W/L) in S. okutanii were significantly different from the mean values and variances of the same indices of S. beringiana (Table 5). Besides, unlike S. beringiana, S. okutanii has a thinner, semitransparent shell with slightly convex pos-terodorsal margin, relatively longer posterior teeth of the hinge, almost horizontally located posterior adductor muscle, less deep pallial sinus, fewer palp ridges.

Etymology

The species name honors Professor, Dr. T. Okutani, a noted malacologist who made a great contribution to the study of the molluscan fauna of the northwestern Pacific.

Remarks

Like most species of the genus Silicula, the posterior shell end of S. okutanii becomes longer as it grows, and the beaks are thus dis-placed anteriorly. In contrast to S. beringiana, S. okutanii has a transparent shell through which the body is well visible. However, | failed to determine the sex in all examined specimens of this species as they showed no sign of go-nadal development.
Silicula okutanii is an abyssal species. This is the most deep water species of the genus Silicula. All specimens of S. okutanii were re-corded in all samples collected with the different

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sampling gear atthe two southernmost stations
of the KuramBio expedition conducted at the
coast of Japan at depth greater than 5,200 m.
Most often, there were several specimens in a sample. Thus, $. okutanii, while not forming
the mass aggregations of S. beringiana in the abyssal of the Bering Sea is, neverthe-less, a fairly common, though not numerous species ofthe deep-sea macrobenthos fauna. Interestingly, S. okutanii was not found at the other 10 stations of the KuramBio expedi-tion conducted to the north of Japan (up to the latitude of the northern Kuril Islands) at 4,859-5,780 m depths. It is possible that in the northwestern Pacific at latitudes north of Japan this species either may be rarer or may not occur whatsoever.

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